

**Supplemental Environmental Analysis
For Purposes of
2003-2004 Dredging
(Lower Snake and Clearwater Rivers, Washington and Idaho)**

Attachment G

Hydrology

Drawdown/Sediment Flushing Discussion

The concept of a drawdown/sediment flushing measure is to draw the reservoir down 10 to 15 feet below Minimum Operating Pool (MOP), increasing water velocity in an attempt to move sediment downstream out of the navigation channel in lieu of dredging. The increased water velocity should resuspend some of the deposited sediment material into the water column. This material would move downstream to a point where the reservoir backwater effect slows the water velocity, causing the material to drop out, or deposit.

A shallow drawdown would move some material from the federal navigation channel. However, it is unlikely that it would remove all of the material from the problem areas. An overlay of the defined federal navigation channel in the confluence area is placed on aerial photos depicting the original bottom of the historic river channel (*i.e.*, thalweg) in both the Snake and Clearwater Rivers. (see Plate 2 in the main report). If the sediment deposits within the navigation channel as it did historically, dredging would still be needed to clear these areas within the navigation channel.

The location that exhibits a significant change in velocity is the zone near the area that, under normal operating conditions, would have been at the upstream end of the reservoir. Under a drawdown scenario, the river in this zone would be converted to a free-flowing river reach. The effect of the drawdown is to relocate the mechanisms that commonly occur at the upstream end of a reservoir (*i.e.*, water velocities slow down and the more coarse-grained material begins to settle out). The reach that is no longer shielded by the reservoir condition is now “activated” and material that ordinarily would not be disturbed in the reservoir condition may now be resuspended into the water column and moved downstream. As a result, material that is removed from the “activated” zone would tend to be deposited near the reach where the reservoir effect again begins to impact the water velocities.

As an example, when the Lower Granite reservoir was drafted to elevation 697 (36 feet below MOP) in the 1992 drawdown test, the upstream end of the effect within the reservoir moved from RM 147 downstream to approximately RM 136. Along the Snake River between these two locations (about 11 miles), water velocities were significantly different than would have been observed under normal pool levels in this reach. Material was picked up in this reach and moved downstream. However, the significant impact to velocity was limited to approximately an 11-mile reach of river out of the 40-mile normal reservoir length. This condition was observed during a major drawdown of 36 feet (Lower Granite Dam forebay elevation 733 fmsl to 697 fmsl) with a relatively small discharge of about 35,000 cfs. While a drawdown increases the velocity in the upstream portion of a reservoir, it has only a minor effect on the velocity of the water in the remainder of the reservoir.

Effective movement of sediment in the upper end of the reservoir, with a limited drawdown of 10 to 15 feet (3.05 to 4.57 meters) and similar flows entering the reservoir, would be much less than what was observed during the 36-foot drawdown discussed above. Implementation of a drawdown during higher discharges would tend to move the upstream limit of the reservoir effect further downstream. A 15-foot drawdown during a 120,000 cfs Snake River discharge (a typical spring runoff discharge) would essentially relocate the upstream end of the reservoir downstream to approximately Snake RM 138, which is about a mile downstream from the Snake/Clearwater River confluence. Plate 1 of the main report includes a comparison of the reservoir conditions of the 36-foot drawdown (tested in 1992), at the proposed 15-foot drawdown, and the reservoir under its normal operating conditions. Plate 1 also illustrates two significant concerns. The plate shows that a 10- to 15-foot drawdown would increase velocities significantly in only the upper 9 miles out of the 40-mile reservoir. Additionally, a 10- to 15-foot drawdown at lower discharges would most likely have a limited effect on the velocities in the Snake/Clearwater confluence area.

The sediment mobilized in the confluence area due to a drawdown would be primarily material that is currently located in the vicinity of the thalweg. Any material that is in the dewatered zone between the drawdown elevation and MOP elevation will not be resuspended and transported downstream, unless local runoff moves it into the water. The resuspension of other material (outside the thalweg) below the drawdown water surface would be dependent on the local water velocities affecting the material, as well as grain size and soil characteristics of the material.

Sediments within the navigation channel and through the Lewiston-Clarkston reach are predominantly sandy sediments. Because of the larger grain size of this material (as compared to fine-grained material, such as clay or silt), these sediments would not move very far downstream under a 10- to 15-foot (3.05 to 4.57-m) drawdown, and a considerable amount of this material may eventually need to be dredged from the channel. The finer-grained silty sediments mobilized by drawdown/sediment flushing are likely to create significantly more turbidity throughout the system than dredging. Some of this material could eventually settle in side channels, public use areas and basins, likely requiring dredging at these locations.

This type of drawdown would not move sediments far enough downstream to assist in increasing the freeboard in the Lewiston Levee reach. The Corps has determined that any material dredged from the confluence area would not be deposited in-water upstream of RM 120, as material deposited in-water upstream of that point could actually raise the water surface profiles through the levee reach (i.e. reducing the freeboard).

27 February 2001

MEMORANDUM FOR: Chief, CENWW-PL-PF ATTN: Jack Sands

THRU: Chief, H & H Branch
Chief, Engineering Div.

SUBJECT: Lower Granite Lock and Dam: Sedimentation update based on the year 2000 sediment-range resurvey and previous surveys.

1. Sediment-range resurveys are typically performed every three years on Lower Granite Pool. Changes in the volume of sediment and its effect on the Standard Project Flood profile for Lower Granite Project are periodically updated, based on these resurveys. The last update was based on the 1995 re-survey. This update includes the results of the 1997 re-survey as well as the 2000 survey.

2. The following materials are attached:

- a. A table indicating accumulated volumes of sediment.
- b. A chart comparing the predicted rise in the Standard Project water-surface profile with "experienced" changes.
- c. Charts indicating SPF profiles for the Snake and Clearwater Rivers.
- d. Maps indicating sediment range locations.
- e. Cross-section charts indicating sediment accumulation and lateral distribution of sediment in each Sediment Range since project completion. (Larger single-range over-plots are available on request)
- f. Over-plots of a sequence of resurveys in the dredge-material disposal areas.

3. Based on the 2000 survey, the pool now contains an estimated 68 million cubic yards (mcy) of sediment. This represents an increase of 21 mcy since the last update in 1995, or 8 mcy since the 1997 resurvey. The overall average yearly sedimentation-volume, based on data collected since completion of the project in early 1975, is 2.6 mcy/yr. It may be of interest to note that the average was 3.0 mcy/yr from 1974 through 1986, 1.3 mcy/yr from 1986 through 1995, and 4.2 mcy/yr from 1995 through 2000. The 1986 to 1995 period was characterized by an unusually long sequence of low peak-flow years. Several unusually high flows since 1995 brought down enough sediment to nearly make up for the lean years. Accumulated sediment volumes are listed by year in the attached Table: "Lower Granite Pool Sediment Volumes."

4. The accumulation of sediment tends to reduce the capacity of the channel and raise the calculated water-surface profile for major flood events. The Standard Project Flood (SPF) for Lower Granite Pool is 420,000 cfs downstream of the Clearwater Confluence; 150,000 cfs on the Clearwater, and 270,000 cfs on the Snake River upstream of the confluence. The progressive loss of SPF freeboard on the Lewiston-Clarkston Levees is one method of tracking the effects of sediment buildup in the reservoir. At the end of

year 2000, the estimated SPF freeboard on the Lewiston Levees was 2.3 feet. An additional 0.5 feet of freeboard would be lost if sediment in the confluence area was allowed to build up to the level it reached in 1985. These figures were based on HEC-2 backwater modeling which assumes a fixed bed. During an actual flood event changes in the channel cross-section during the flood will affect the water-surface profile.

Beginning with the initial filling of the reservoir in the Spring of 1975, sediment has progressively reduced the conveyance of the pool. By 1982 sediment was interfering with navigation in the Clearwater arm of the reservoir. By 1984 sediment had built up to within 6 feet of the minimum-pool water surface elevation at one or more points in the confluence area, and the SPF freeboard had been reduced to 3.0 feet. The sediment level rose even higher in 1985. Since 1985, a number of factors have combined to slow, or even temporarily reverse the profile rise: 1) About 4.4 mcy of sediment has been dredged from the confluence. 2) Over 1 mcy of sediment was shifted downstream during the 1992 drawdown; and 3) The area experienced an unusually long period of low-flows extending from 1986 through 1995. The attached chart compares the predicted rise in the SPF water-surface elevation (assuming no corrective action) with the documented changes through the year 2000.

5. The in-water disposal areas between RM 118.5 and 120.5 have been re-surveyed periodically since the first material was placed there in 1986. The objective was to monitor erosion or changes in deposition resulting from the dredged-material placement.

Most of the disposal area surface appears to be covered by sand-dunes. These dunes were created by individual barge dumps rather than water action. While inspecting this area, during the 1992 drawdown, it was noted that sediment was not accumulating on the tops of the sand dunes, but rather in the low areas between dunes. The 1997 re-survey suggests that up to two feet of silt has collected in these low areas, and that around 10 feet of sediment has collected on the river-ward side of the Mid-Depth Disposal Area.

Centennial Island has experienced some erosion, mainly on the unprotected, shoreward side. The Deep-Water Disposal Area appears to be collecting sediment on the upstream and downstream slopes, but none on the top of the disposal mound. In fact, the top of the mound, between Station 18+00 and 24+00, appears to have been rounded off and possibly lowered about two feet from its maximum height. (Although this small change could have resulted from a surveying anomaly or settling). Most of the change, indicated in the over-plots for both areas, resulted from the placement of new material during dredging operations.

6. Questions regarding this material should be addressed to Lester Cunningham, Extension 7291.

David L. Reese

Chief, Hydrology Section

LOWER GRANITE POOL SEDIMENT VOLUMES

Total accumulated sediment in cubic yards based on periodic sediment-range resurveys.

YEAR	SNAKE	CLEARWATER	DREDGED MATERIAL	ACCUMULATED DREDGE VOL	TOTAL VOLUME
1974	0	0	0	0	0
1976	11779593	502378	0	0	12281971
1977	14213230	621409	0	0	14834639
1979	15169102	485699	0	0	15654801
1982	19064517	728032	256175	256175	20048724
1983	25225441	738838	5000	261175	26225454
1984	29148171	955285	0	261175	30364631
1985	28401433	685579	0	261175	29348187
1986	33727417	989306	450000	711175	35427898
1989	39323124	545282	873289	1584464	41452870
1992	40110539	220434	475400	2059864	42390837
1995	44422147	208246	0	2059864	46690257
1997	56610948	732711	30000	2089864	59463523
2000	64455340	937425	118000	2207864	67600629

Notes:

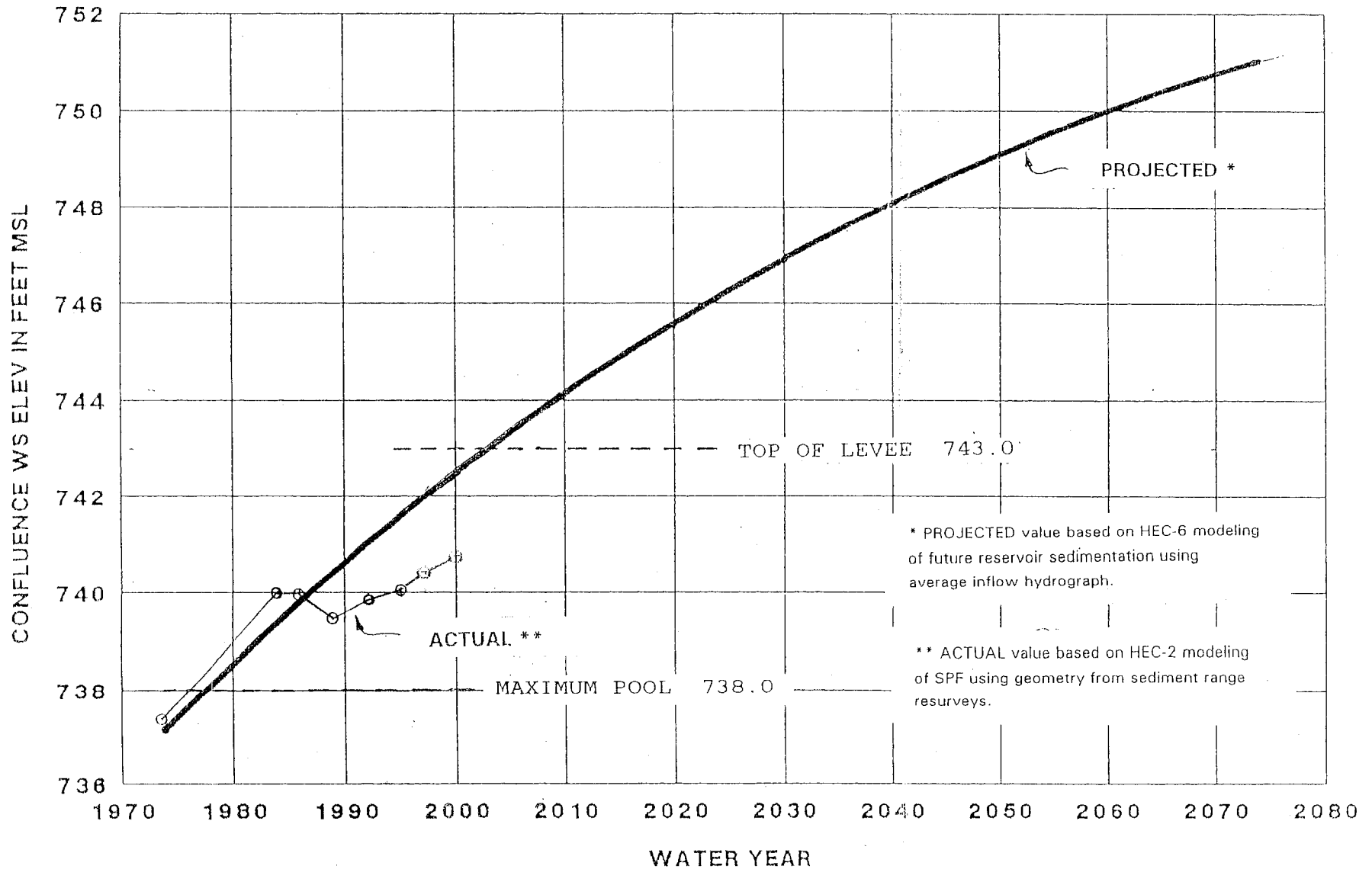
1. "DREDGED MATERIAL" is that portion of the total volume of material dredged from the confluence area which was placed either on-land or in the deep-water site at locations where it would not have been included in computations based on the average end area method. In 1997 and 2000 it was assumed that one-half of the material dredged from the confluence area might not be accounted for in disposal areas downstream.

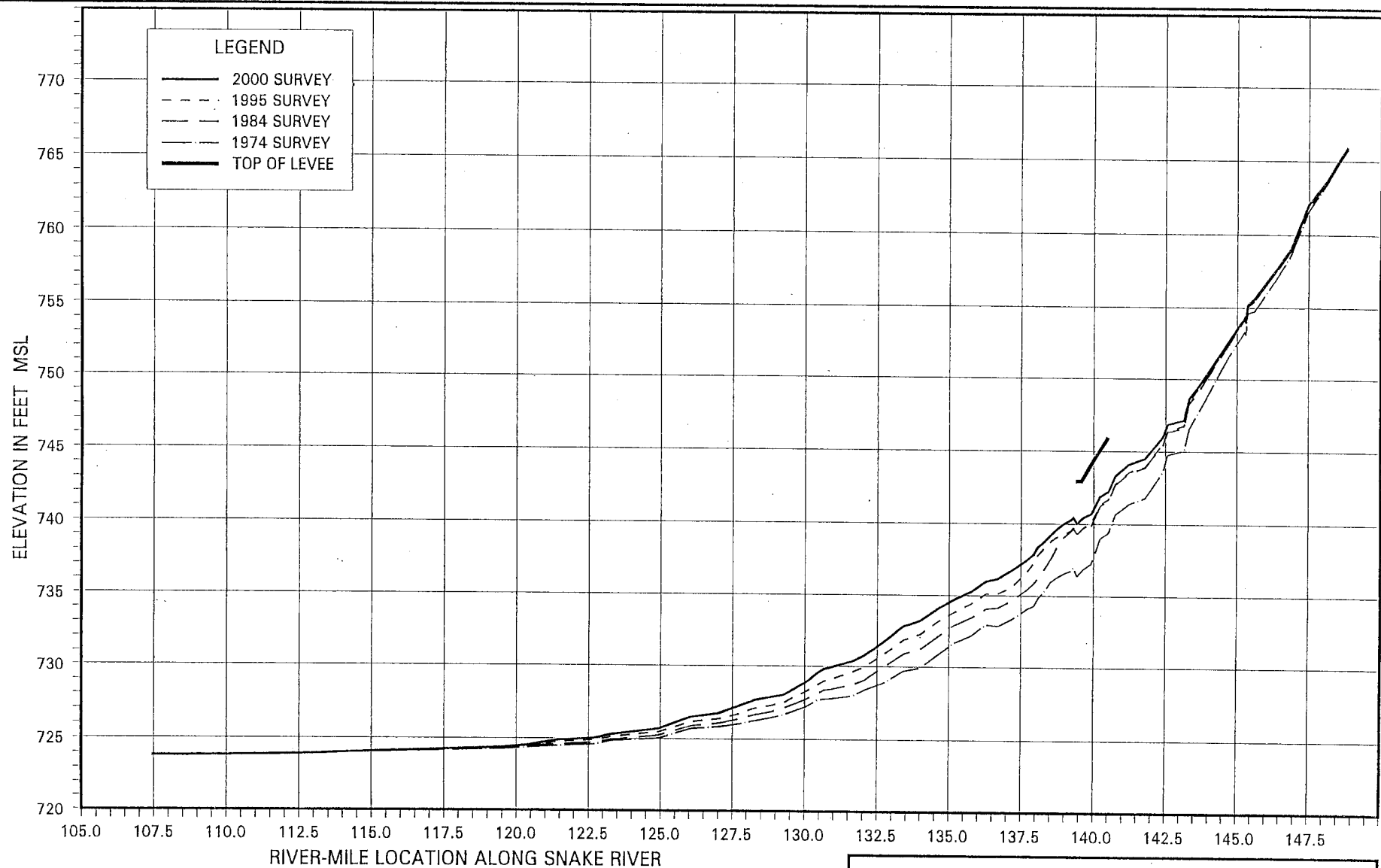
2. "TOTAL VOLUME" is the sum of accumulated sediment volume from the Snake, Clearwater, and the accumulated dredge material from 1974 to the indicated date. Volume computations were performed by the average end-area method comparing sediment range re-surveys with the 1974 survey. Surveys generally represent conditions at the end of the listed Water Year. Listed values are carried out to 8 significant figures for mathematical consistency only.

3. An analysis of sediment range overplots strongly suggests that some of the surveys performed prior to 1986 were out of calibration by as much as 2 or 3 feet in the deepest part of the pool. The error was probably due to failure to properly adjust for water temperature or temperature variations in the reservoir. In addition, resurveys of individual sections often resulted in anomalies which could affect the volume computations. These included linear horizontal expansion or contraction of a range with respect to previous or subsequent surveys, missing data, and local variations related to surveying off-line. Obvious errors in individual ranges were corrected where possible. Where entire surveys were in error, a uniform correction-factor, proportional to the depth, was applied. Corrections were based on the assumption that the velocity of sound was in error by the same magnitude throughout the reservoir; and that subsequent resurveys should indicate either no change or a progressively increasing depth of sediment in the lower portion of the reservoir.

Even after correction of obvious errors, enough uncertainty remained to account for several million cubic yards (mcy). A systematic linear error equivalent to 0.5 ft in the deepest part of the pool would change the calculated volume by more than 3 mcy, indicating that a small error can significantly affect the calculated volume. The possible error in calculating the sediment accumulation based on sediment range resurveys is likely to be greater than the average sediment accumulation for a single year. Due to the above uncertainties, volume differences between successive surveys are not significant, and values for individual years are only meaningful in relation to the overall total accumulated volume.

LOSS OF FREEBOARD DUE TO SEDIMENTATION
CPRR BRIDGE LOCATION - STANDARD PROJECT FLOOD

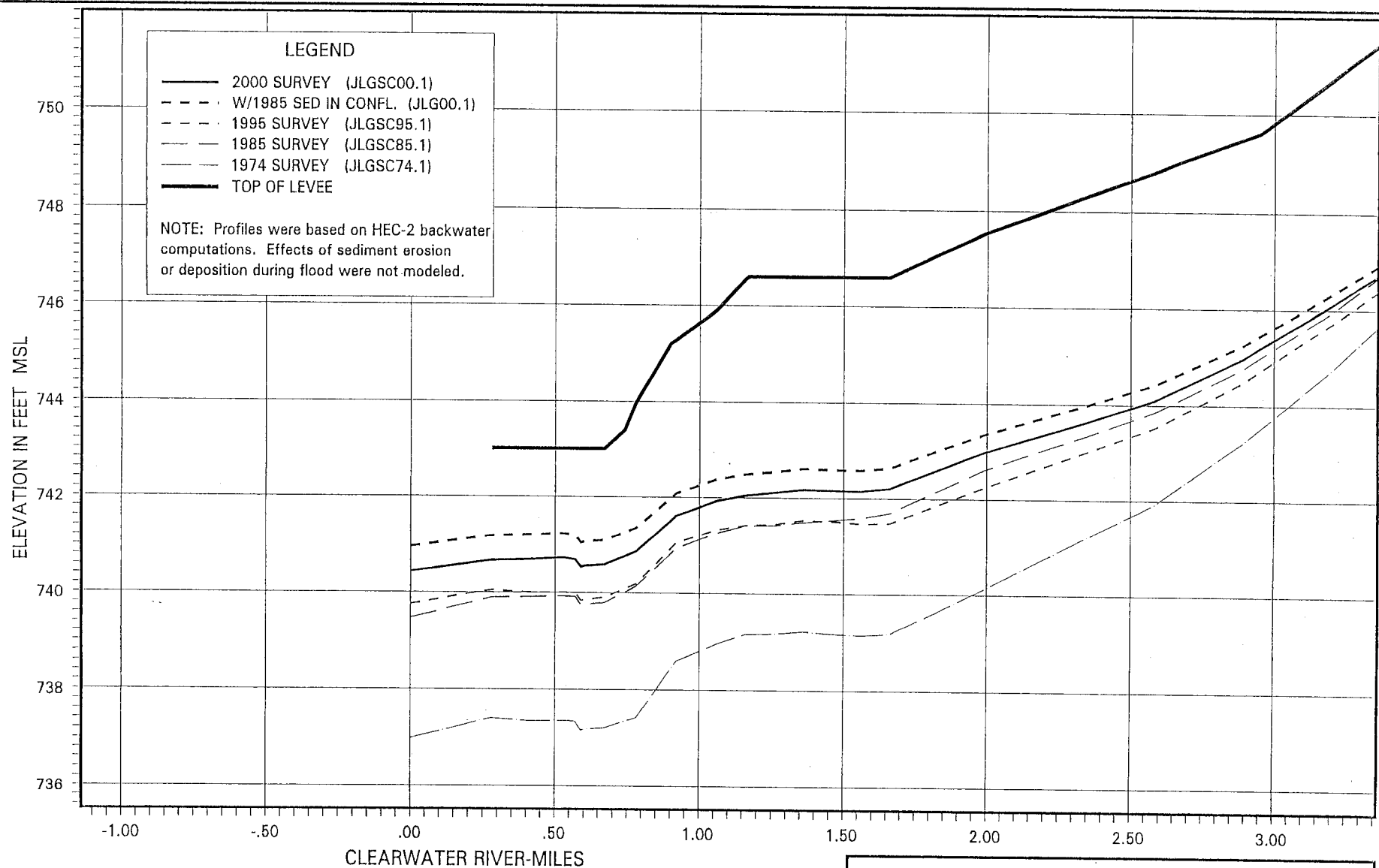




**SNAKE RIVER, LOWER GRANITE POOL
STANDARD PROJECT FLOOD PROFILES**

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

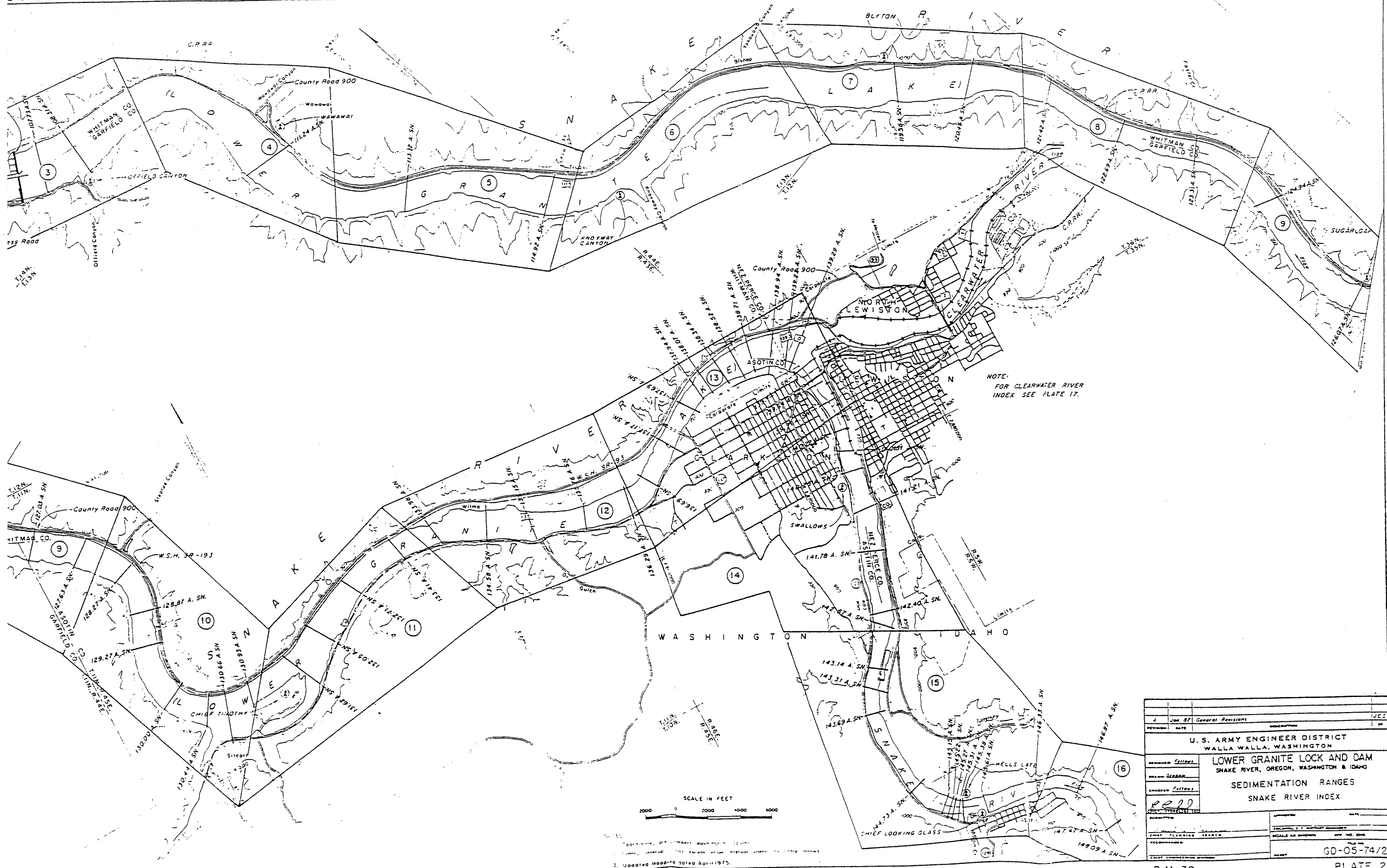
2 JAN 2001

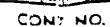


CLEARWATER RIVER. LOWER GRANITE POOL
STANDARD PROJECT FLOOD PROFILES

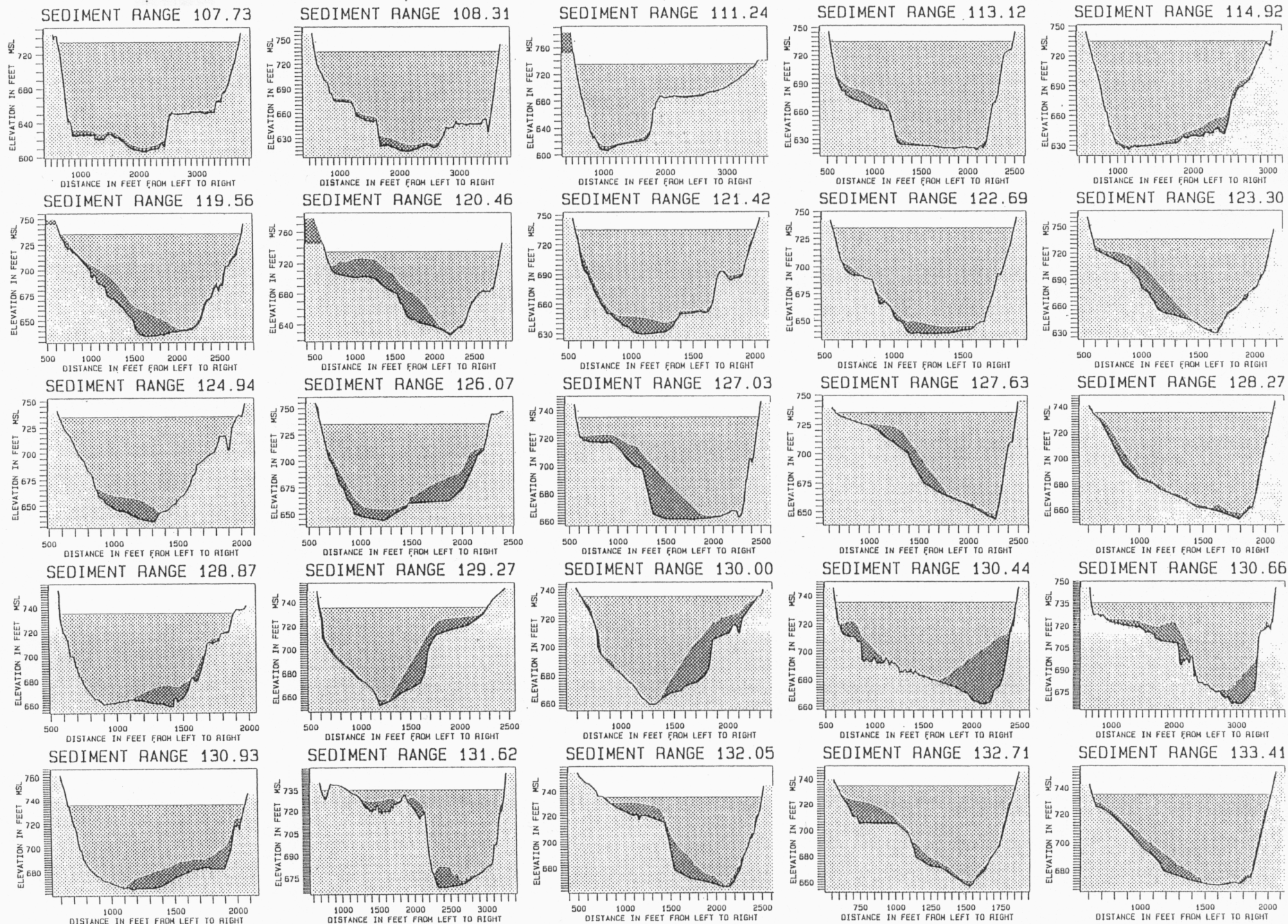
U. S. Army Corps of Engineers
Walla Walla District
Hydrology Section

L. Cunningham 23 FEB 2001

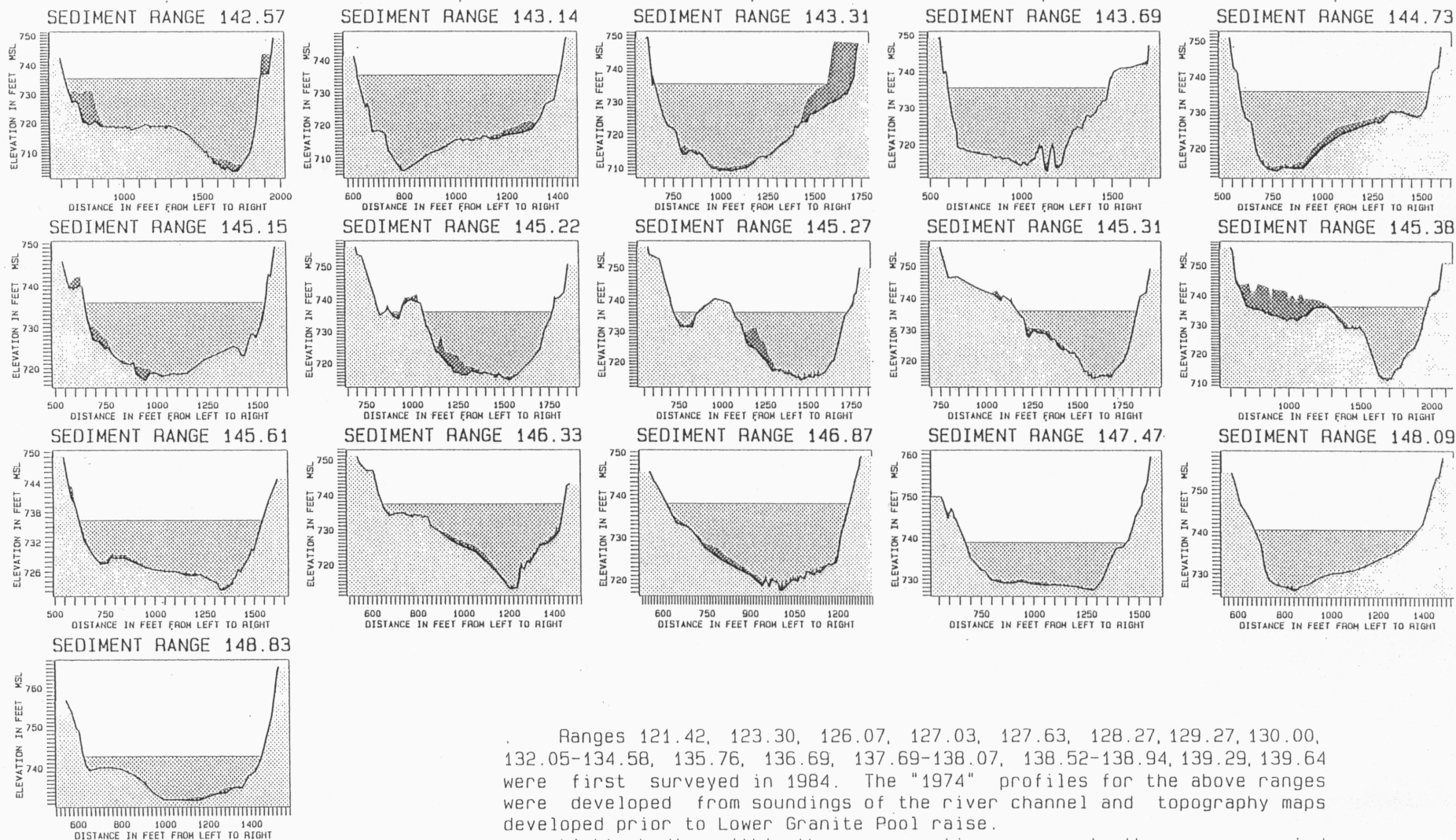




LOWER GRANITE POOL: SNAKE RIVER. SEDIMENT RANGES: 1974 AND 2000 SURVEYS COMPARED



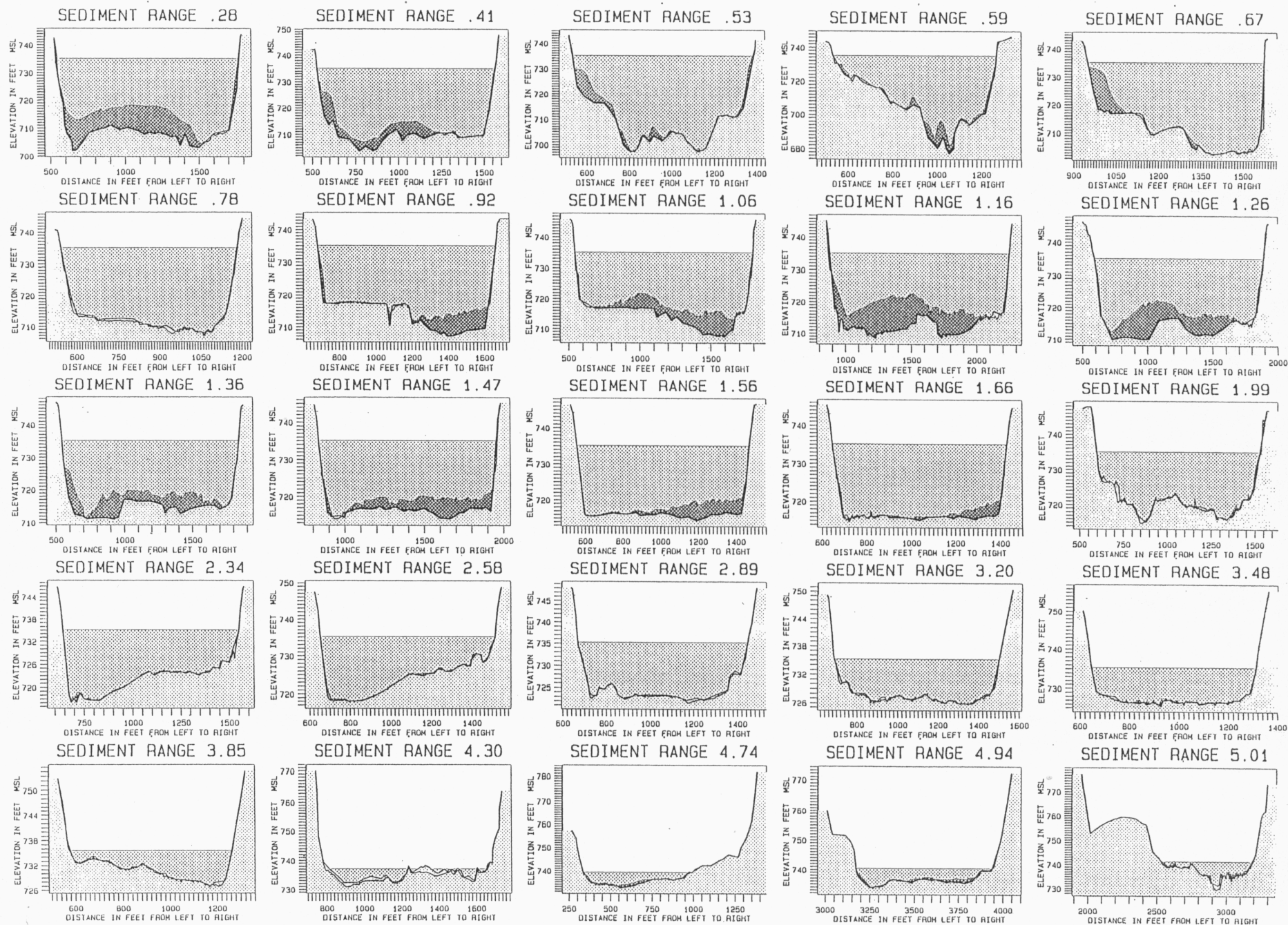
Distance (ft)	Elevation (ft)
500	740
600	680
750	650
1000	670
1250	690
1500	700
1750	725
2000	725
2250	730
2500	740

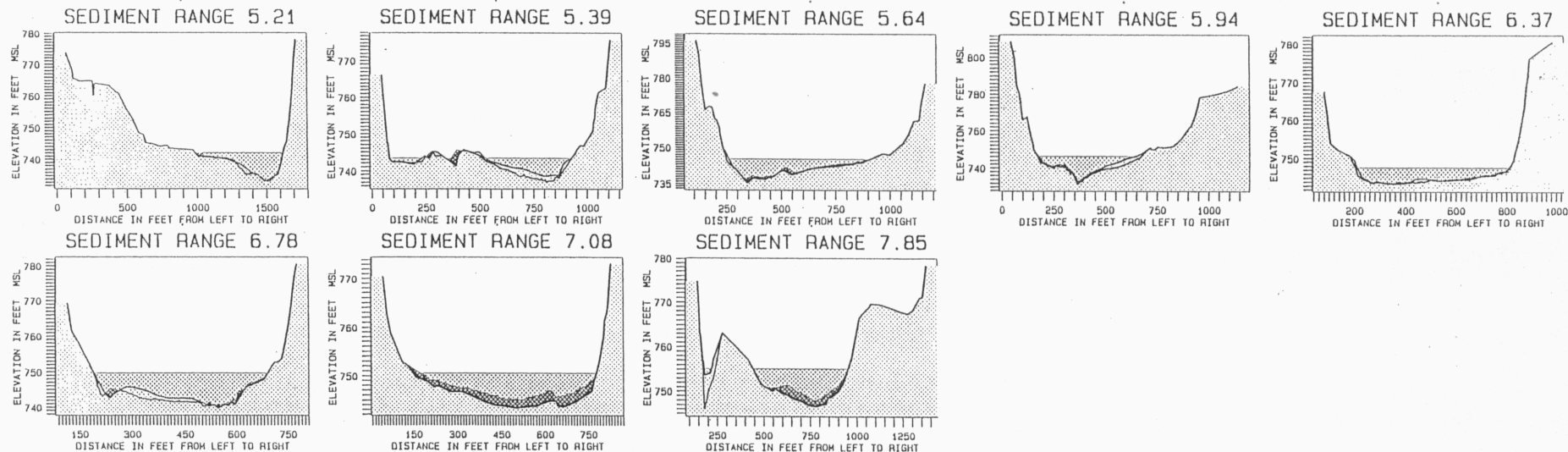


Ranges 121.42, 123.30, 126.07, 127.03, 127.63, 128.27, 129.27, 130.00, 132.05-134.58, 135.76, 136.69, 137.69-138.07, 138.52-138.94, 139.29, 139.64 were first surveyed in 1984. The "1974" profiles for the above ranges were developed from soundings of the river channel and topography maps developed prior to Lower Granite Pool raise.

Light shading within the cross-section represents the area occupied by water at the time of the 2000 survey, assuming a forebay water-surface elevation of 735.00 (NGVD 1929) and a discharge of 40,000 cfs below the confluence. The dark shading in the bottom of some sections indicates the amount and distribution of existing sediment above the 1974 channel bottom. The Snake River channel in the confluence area has been dredged several times beginning in 1986.

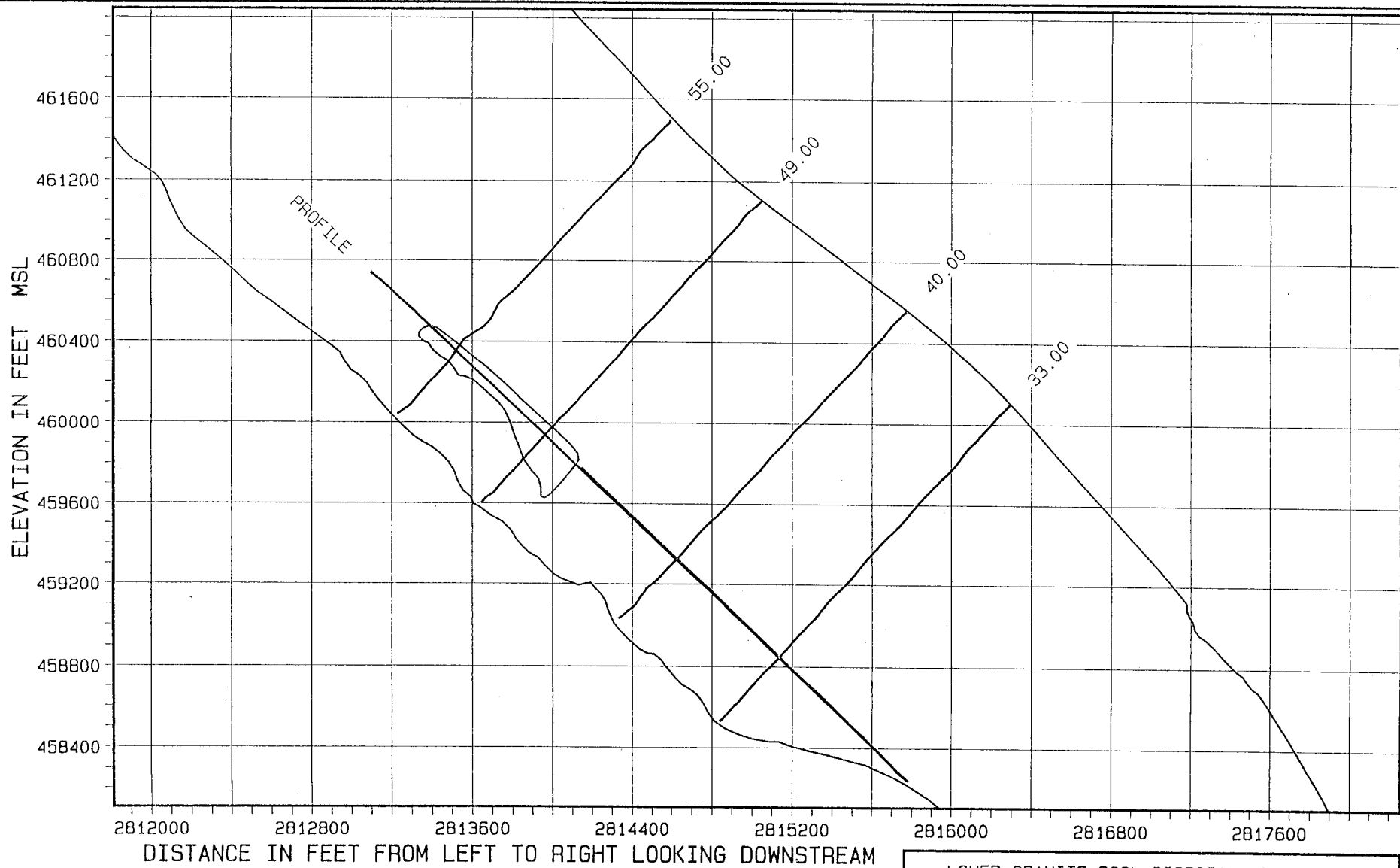
CLEARWATER ARM OF LOWER GRANITE POOL. SEDIMENT RANGES: 1974 AND 2000 SURVEYS COMPARED





NOTE: Ranges 0.28 and 0.53 were not surveyed as sediment ranges until 1984. Ranges 0.41, .59, 1.06, 1.26, 1.36, 1.56, and 1.99 were first surveyed in 1985. The 1974 profiles for the above ranges were developed from intensive topographic or bathymetric surveys performed at or before pool raise.

. Light shading within the cross-section represents the area occupied by water at the time of the 2000 survey, assuming a forebay water-surface elevation of 735.00 (NGVD 1929) and a discharge of 40,000 cfs below the confluence. The dark shading in the bottom of some sections indicates the amount and distribution of existing sediment above the 1974 channel bottom. The channel has been dredged several times since 1974.



LOWER GRANITE POOL DISPOSAL MONITORING
MID-DEPTH & CENTENNIAL ISLAND
U. S. Army Corps of Engineers
Walla Walla District
Hydrology Section
L. Cunningham 21 February 2001

LEGEND

- 1997 SURVEY (MD97P)
- 1993 SURVEY (MD93P)
- 1991 SURVEY (MD91P)
- 1990 SURVEY (MD90P)
- 1989 SURVEY (MD89P)
- 1988 SURVEY (MD88P)
- 1987 SURVEY (MD87P)

Mid-depth profile was surveyed 600 ft left of the survey base line from approximately Station 24+50 to 49+00. In 1997 the range was extended to include all of Centennial Island.

ELEVATION IN FEET MSL

780

765

750

735

720

705

690

2000

2500

3000

3500

4000

4500

5000

5500

6000

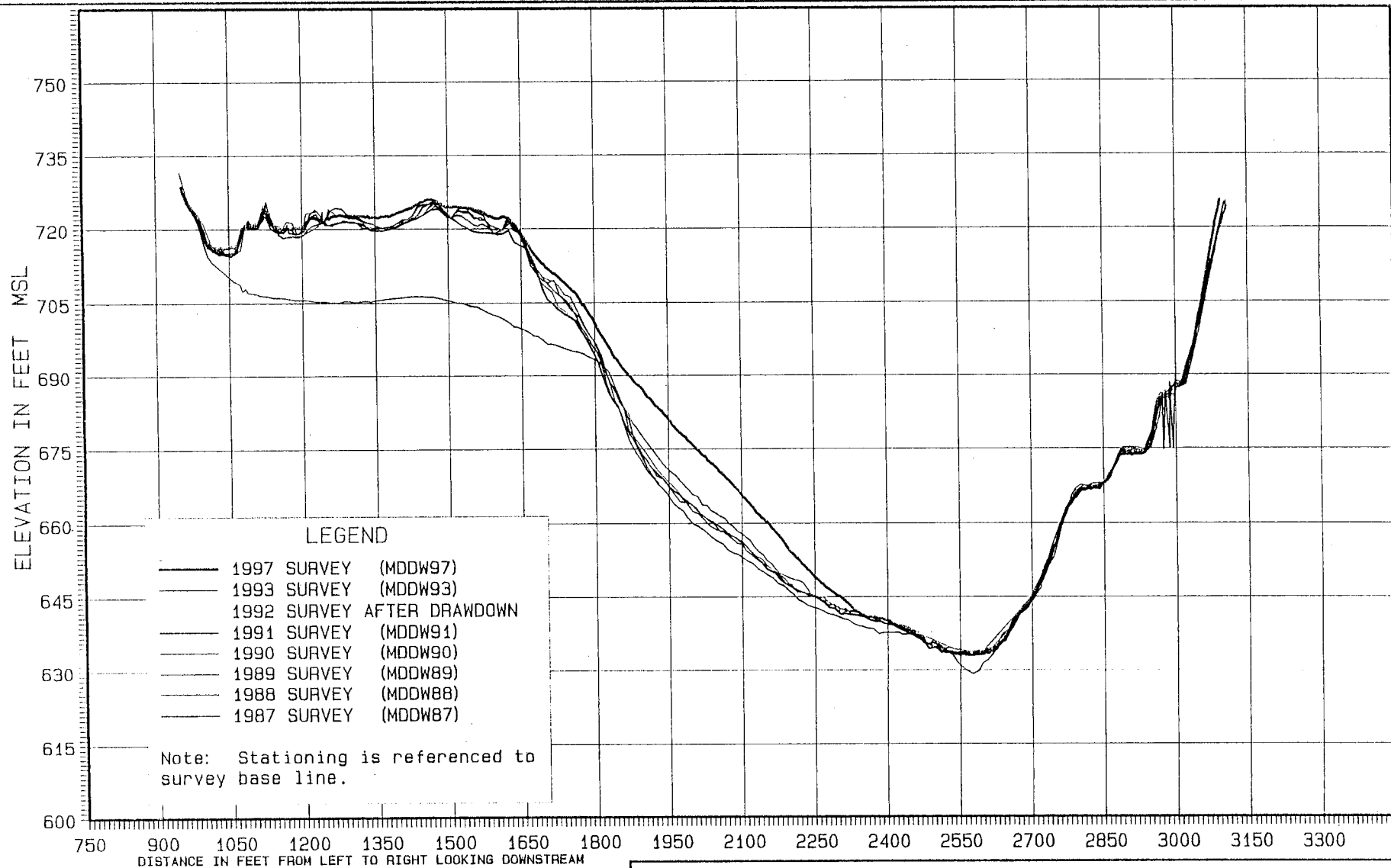
STATION MEASURED ALONG SURVEY BASE LINE

LOWER GRANITE POOL DISPOSAL MONITORING
PROFILE THROUGH CENTENNIAL ISLAND
RIVER-MILE 120

U. S. Army Corps of Engineers
 Walla Walla District
 Hydrology Section

L. Cunningham

21 February 2001



LOWER GRANITE POOL DISPOSAL MONITORING
MID-DEPTH & CENTENNIAL ISLAND. STATION 33.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Section

L. Cunningham 21 February 2001

ELEVATION IN FEET MSL

740
730
720
710
700
690
680
670
660
650
640

LEGEND

- 1997 SURVEY (MDDW97)
- 1993 SURVEY (MDDW93)
- 1992 SURVEY AFTER DRAWDOWN
- 1991 SURVEY (MDDW91)
- 1990 SURVEY (MDDW90)
- 1989 SURVEY (MDDW89)
- 1988 SURVEY (MDDW88)
- 1987 SURVEY (MDDW87)

Note: Stationing is referenced to survey base line.

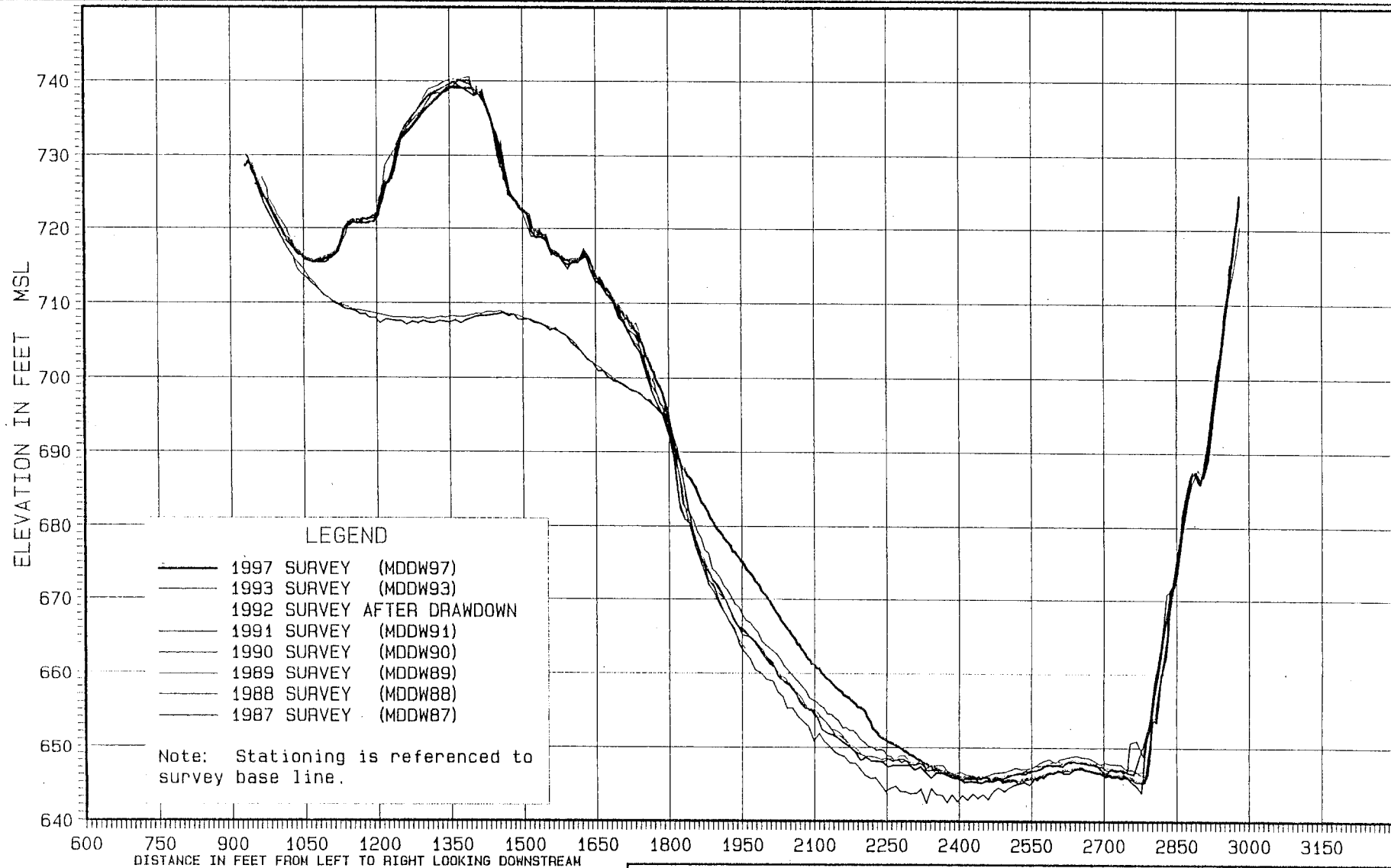
DISTANCE IN FEET FROM LEFT TO RIGHT LOOKING DOWNSTREAM

750 900 1050 1200 1350 1500 1650 1800 1950 2100 2250 2400 2550 2700 2850 3000 3150 3300

LOWER GRANITE POOL DISPOSAL MONITORING
MID-DEPTH & CENTENNIAL ISLAND. STATION 40.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Section

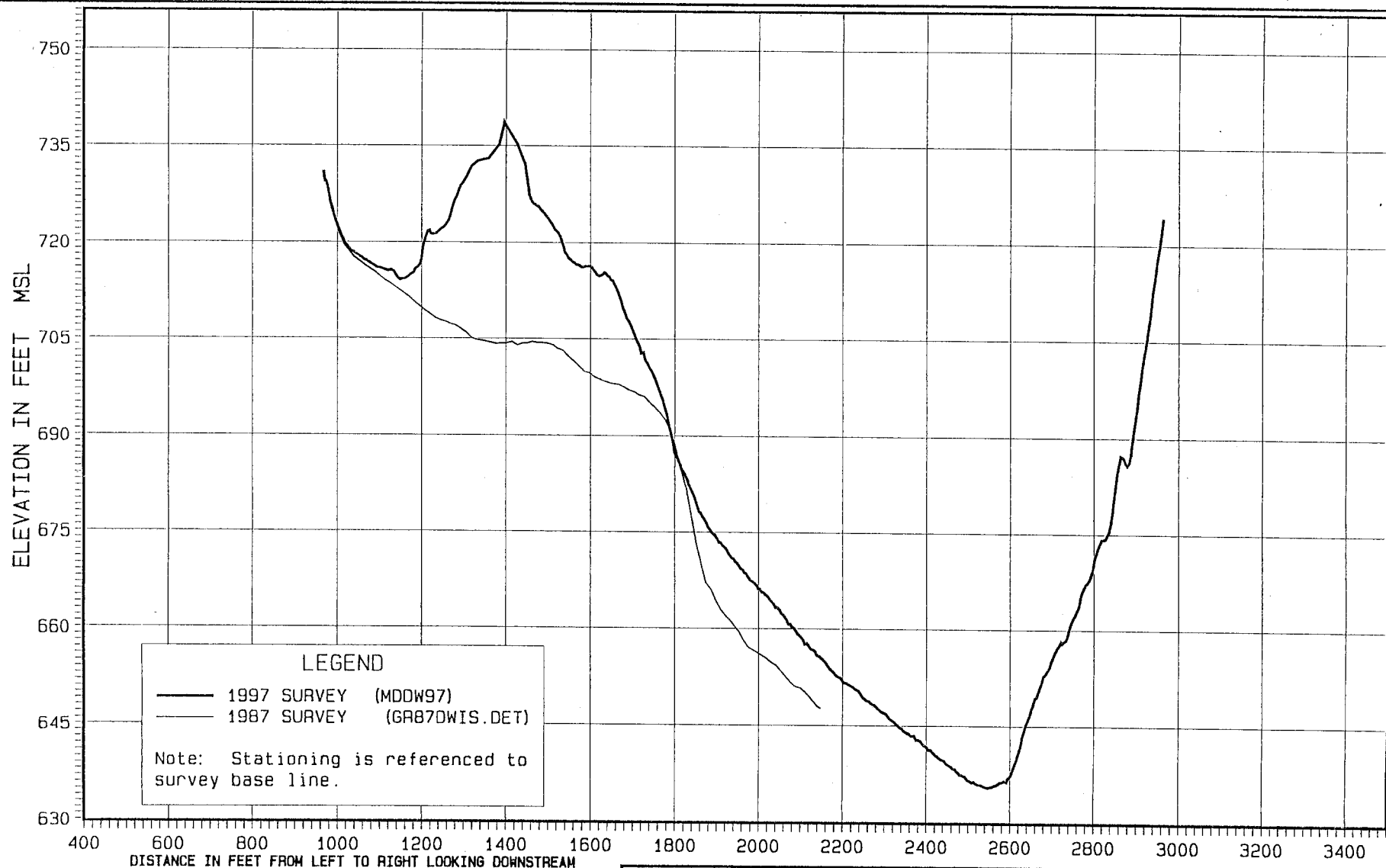
L. Cunningham 21 February 2001



LOWER GRANITE POOL DISPOSAL MONITORING
MID-DEPTH & CENTENNIAL ISLAND. STATION 49.00

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Walla Walla District
Hydrology Section

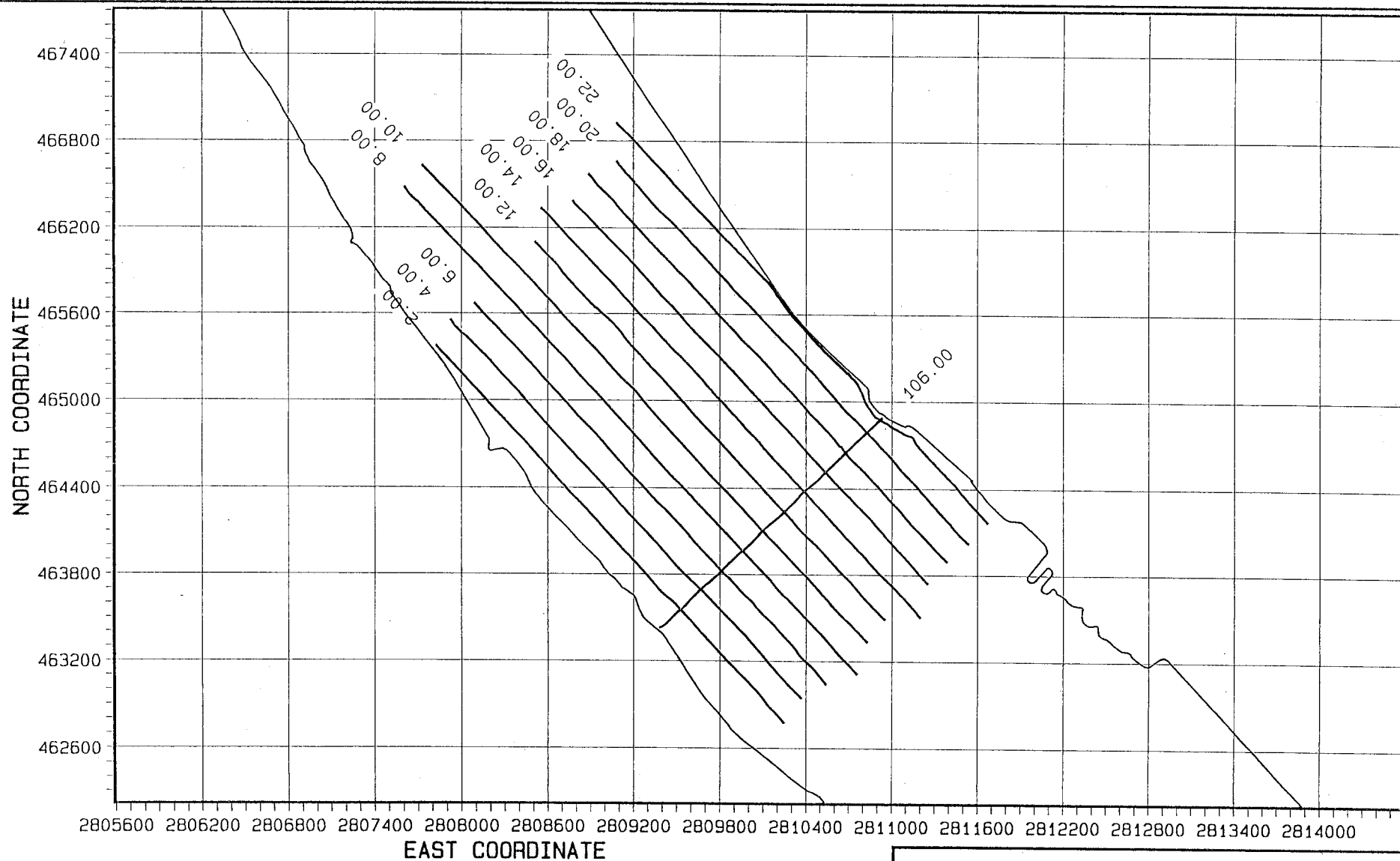
L. Cunningham 21 February 2001



LOWER GRANITE POOL DISPOSAL MONITORING
MID-DEPTH & CENTENNIAL ISLAND. STATION 55.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Section

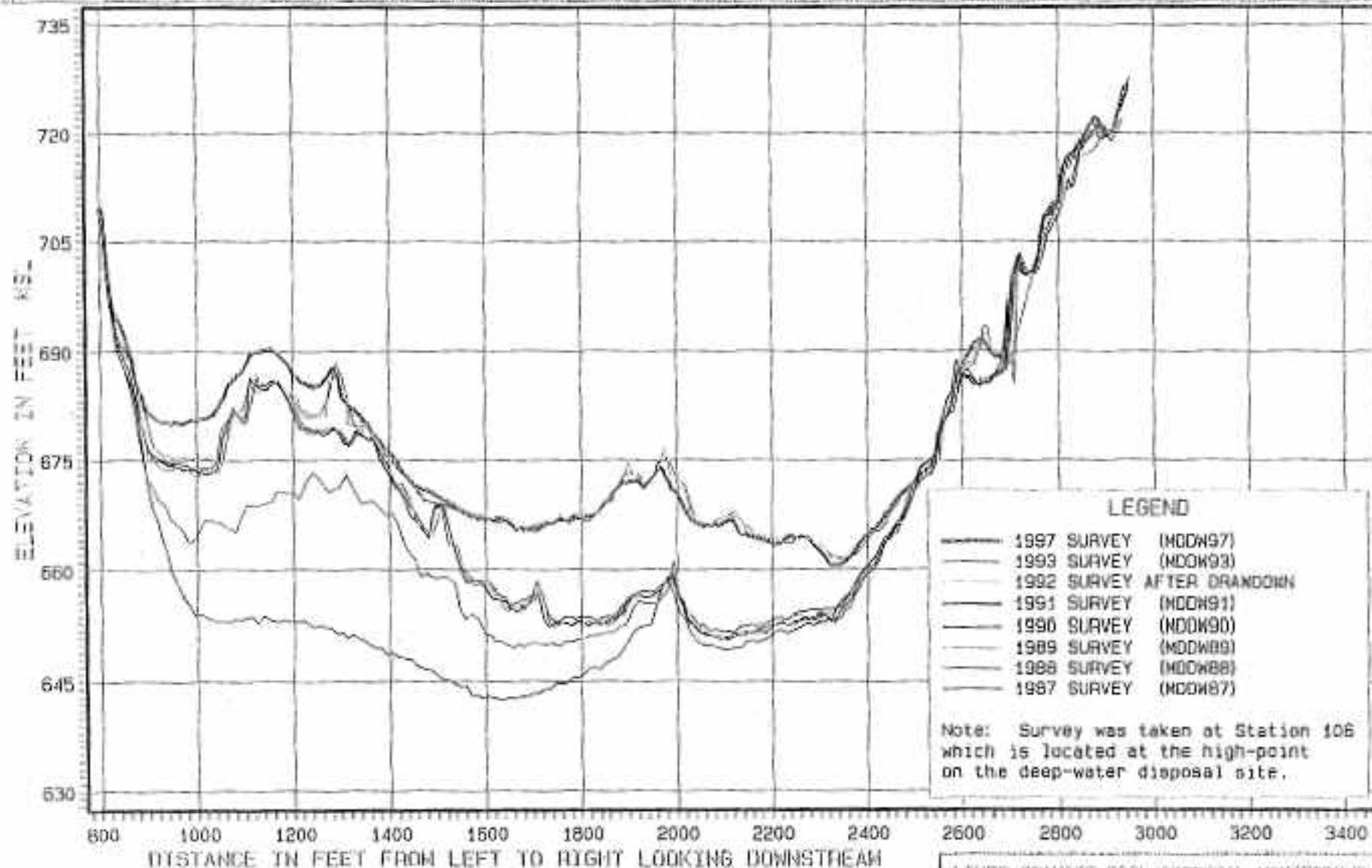
L. Cunningham 21 February 2001



**LOWER GRANITE POOL. DEEP-WATER DISPOSAL AREA
SURVEY LINES FOR 1997 SURVEY**

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

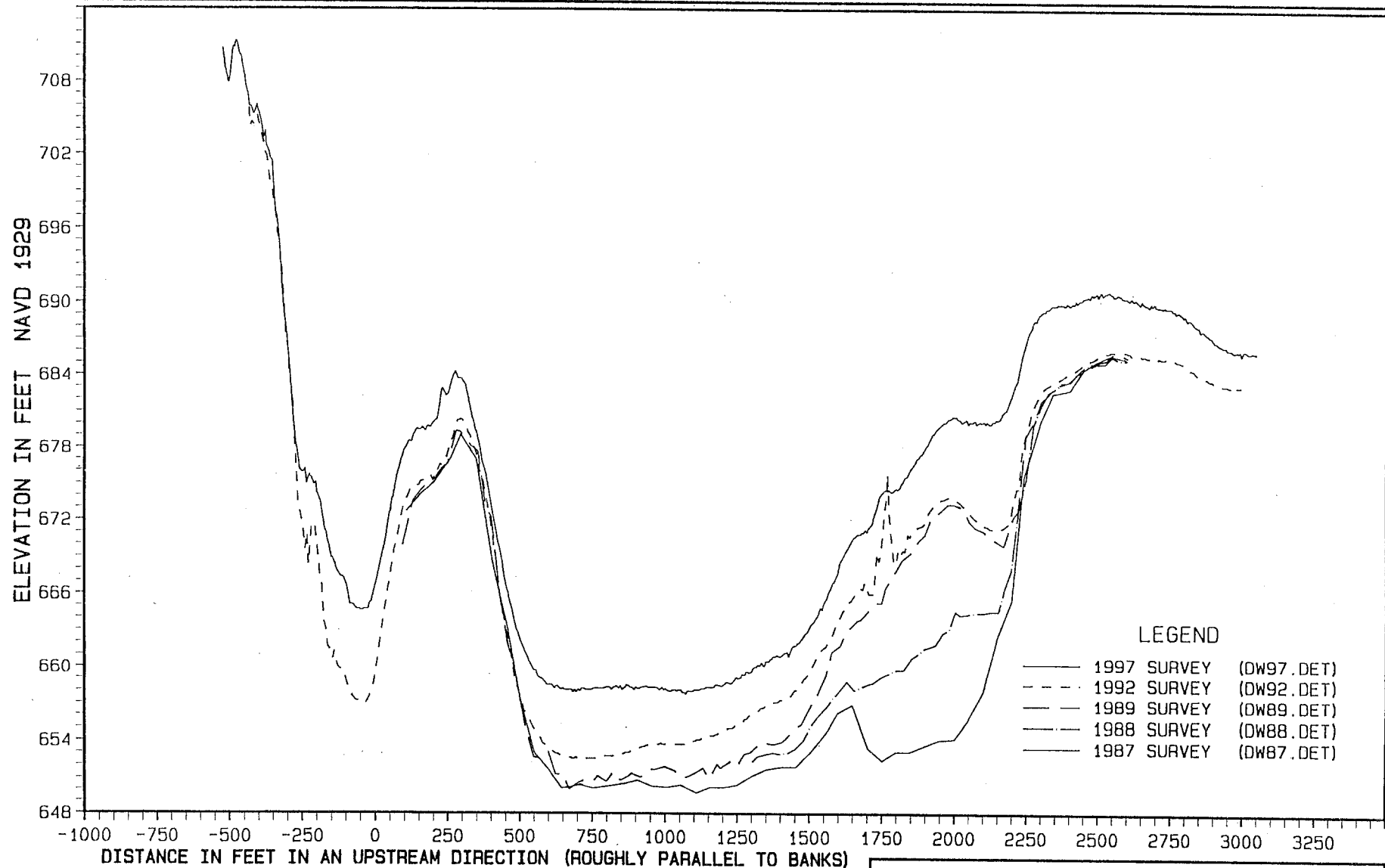
L. CUNNINGHAM 14 FEBRUARY 2001



**LOWER GRANITE POOL DISPOSAL MONITORING
DEEP-WATER DISPOSAL SITE**

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Section

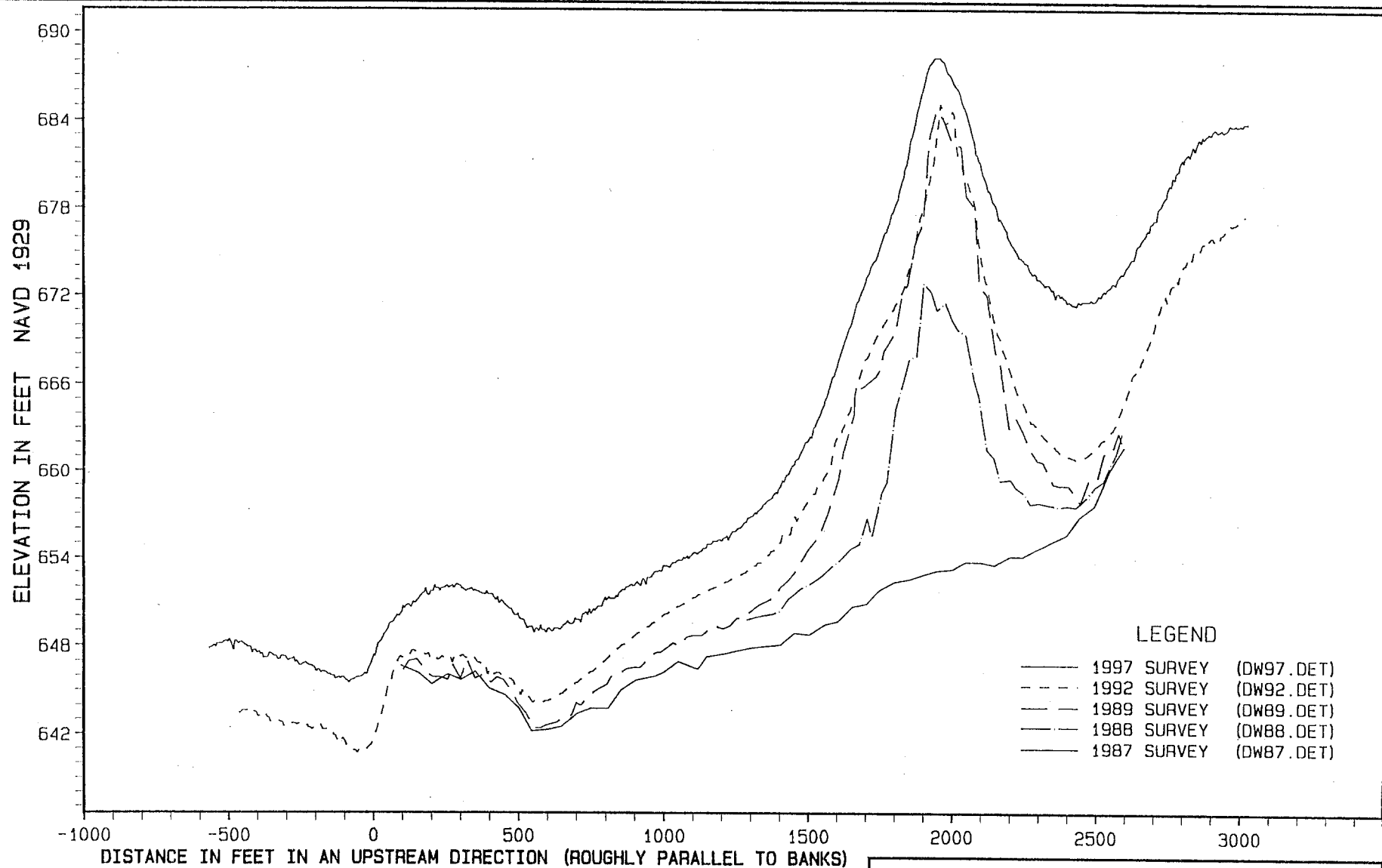
L. Cunningham 21 February 2001



LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 2.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001



LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 4.00

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Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929

680
675
670
665
660
655
650
645
640
635
630

-3500 -3000 -2500 -2000 -1500 -1000 -500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

DISTANCE IN FEET IN AN UPSTREAM DIRECTION (ROUGHLY PARALLEL TO BANKS)

LEGEND

- 1997 SURVEY (DW97.DET)
- - - 1992 SURVEY (DW92.DET)
- · - 1989 SURVEY (DW89.DET)
- · — 1988 SURVEY (DW88.DET)
- 1987 SURVEY (DW87.DET)

LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 6.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929

675
670
665
660
655
650
645
640
635
630
625

-3500 -3000 -2500 -2000 -1500 -1000 -500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

DISTANCE IN FEET IN AN UPSTREAM DIRECTION (ROUGHLY PARALLEL TO BANKS)

LEGEND

- 1997 SURVEY (DW97.DET)
- - - 1992 SURVEY (DW92.DET)
- 1989 SURVEY (DW89.DET)
- 1988 SURVEY (DW88.DET)
- 1987 SURVEY (DW87.DET)

LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 8.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929

672
668
664
660
656
652
648
644
640
636
632

-3500 -3000 -2500 -2000 -1500 -1000 -500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

DISTANCE IN FEET IN AN UPSTREAM DIRECTION (ROUGHLY PARALLEL TO BANKS)

LEGEND

—— 1997 SURVEY (DW97.DET)
- - - 1992 SURVEY (DW92.DET)
— — 1989 SURVEY (DW89.DET)
—— 1988 SURVEY (DW88.DET)
—— 1987 SURVEY (DW87.DET)

LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 10.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929

680
676
672
668
664
660
656
652
648
644
640

LEGEND

- 1997 SURVEY (DW97.DET)
- - - 1992 SURVEY (DW92.DET)
- . - 1989 SURVEY (DW89.DET)
- - - 1988 SURVEY (DW88.DET)
- 1987 SURVEY (DW87.DET)

DISTANCE IN FEET IN AN UPSTREAM DIRECTION (ROUGHLY PARALLEL TO BANKS)

-1000 -750 -500 -250 0 250 500 750 1000 1250 1500 1750 2000 2250 2500 2750 3000 3250

LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 12.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929

675
672
669
666
663
660
657
654
651
648
645

LEGEND

— 1997 SURVEY (DW97.DET)
- - - 1992 SURVEY (DW92.DET)

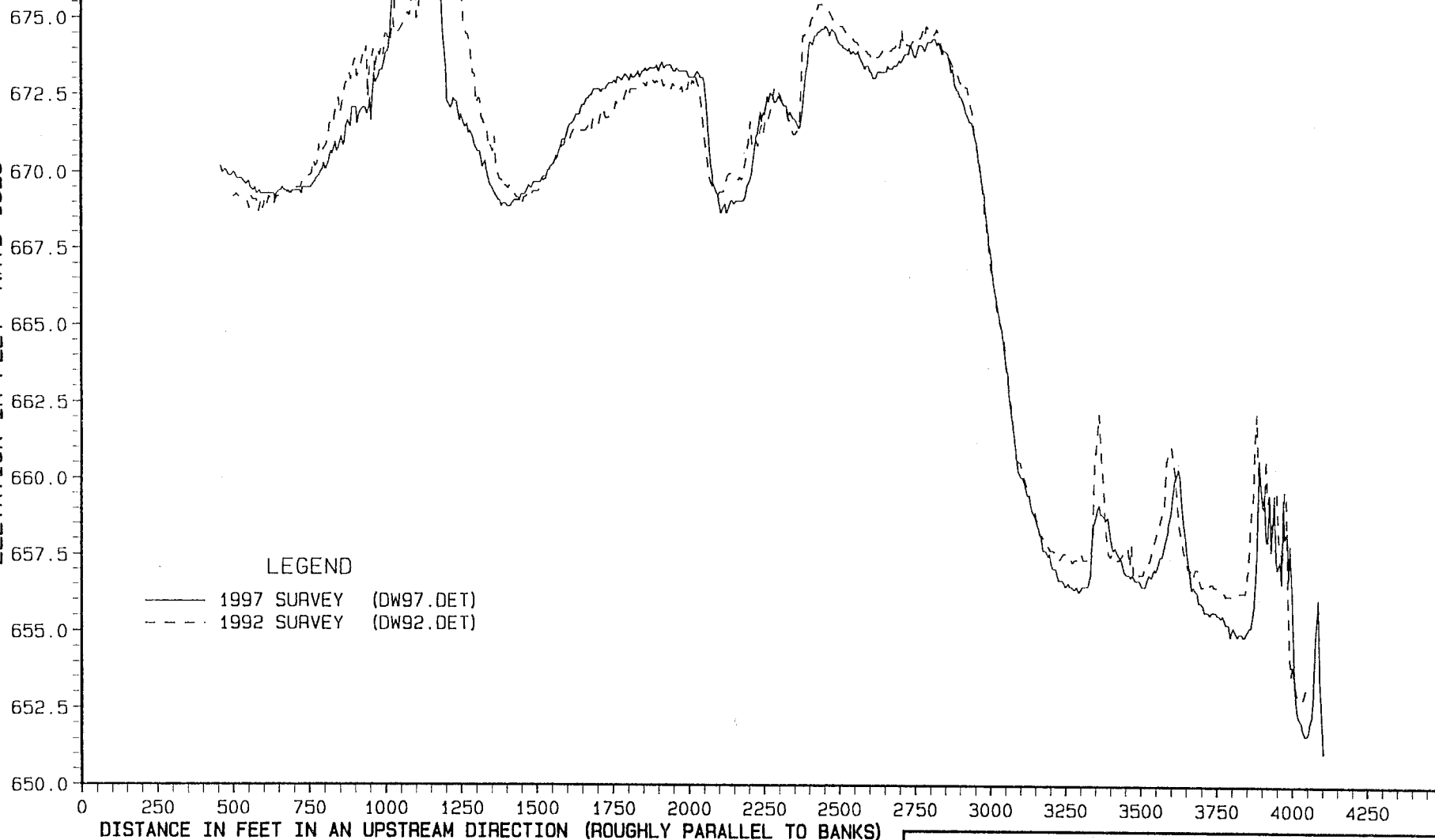
250 500 750 1000 1250 1500 1750 2000 2250 2500 2750 3000 3250 3500 3750 4000 4250 4500
DISTANCE IN FEET IN AN UPSTREAM DIRECTION (ROUGHLY PARALLEL TO BANKS)

LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 14.00

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Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929



LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 16.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929

DISTANCE IN FEET IN AN UPSTREAM DIRECTION (ROUGHLY PARALLEL TO BANKS)

LEGEND

— 1997 SURVEY (DW97.DET)
- - - 1992 SURVEY (DW92.DET)

LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 18.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001

ELEVATION IN FEET NAVD 1929

720
714
708
702
696
690
684
678
672
666
660

DISTANCE IN FEET IN AN UPSTREAM DIRECTION (ROUGHLY PARALLEL TO BANKS)

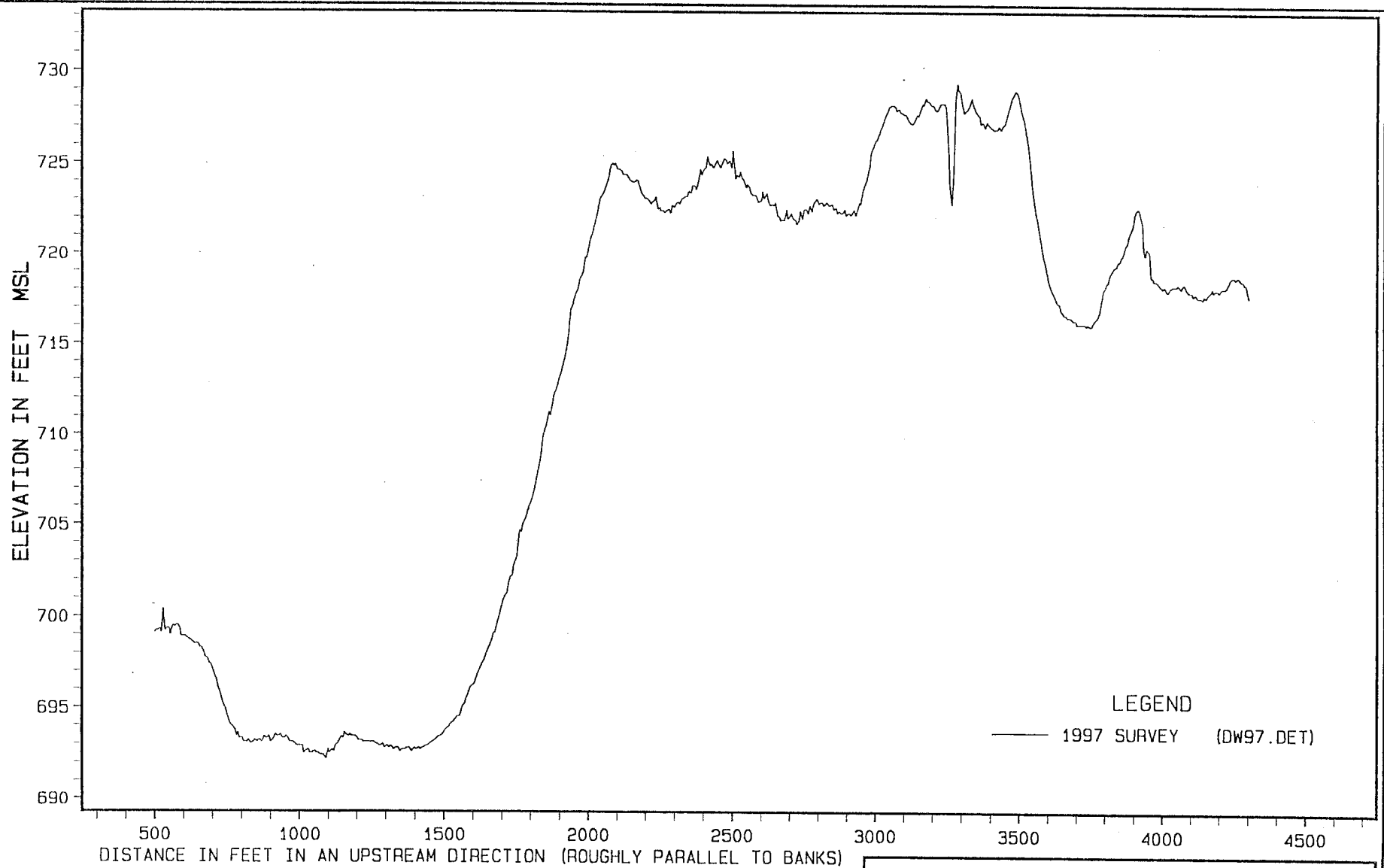
LEGEND

—— 1997 SURVEY (DW97.DET)
--- 1992 SURVEY (DW92.DET)

LOWER GRANITE POOL. DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 20.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

16 FEB 2001



LEGEND

— 1997 SURVEY (DW97.DET)

LOWER GRANITE POOL, DEEP-WATER DISPOSAL SITE
PROFILE AT RANGE 22.00

U. S. Army Corps of Engineers
Walla Walla District
Hydrology Branch

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DREDGE MATERIAL MANAGEMENT STUDY

1. LOWER GRANITE POOL SEDIMENTATION UPDATE.

a. Sediment volume.

Preliminary results from the 1997 sediment-range resurvey indicated that Lower Granite Pool has collected about 59 million cubic yards (mcy) of sediment since the pool was raised in February 1975. This figure represents an increase of more than 12.3 mcy since the last complete survey in 1995, and a 23.6 mcy increase over the amount of sediment in the pool in 1986. Most of the sediment deposition during the last two years has been distributed downstream of the confluence. Many of the confluence ranges and some upstream have actually lost material when compared with conditions in 1986. This is due to several factors: 1) material has been removed by dredging; 2) the 1992 drawdown removed sediment from the confluence; and 3) the unusually high peak flow in 1997 appears to have shifted existing fine-material deposits farther down in the reservoir in addition to bringing in new material.

b. Volume dredged.

Previous studies have used sedimentation conditions existing in 1986 as a base for estimating future freeboard loss and dredging requirements. Since 1986, about 2.9 mcy of sediment has been dredged from the confluence. Approximately 2.5 mcy of this material was placed in-water downstream of River-Mile (RM) 120.5 to create Centennial Island and surrounding shallow-water and mid-depth habitat areas as well as a deep-water site at RM 119. An additional 0.33 to 0.35 mcy is scheduled to be dredged in the confluence area this year, with in-water disposal below RM 120.5. Due to the quantity of sediment that has come in since 1986, sediment transport models will need to be re-run in order to provide reasonable estimates and schedules for future dredging plans. The volumes of material dredged since 1986 are as follows:

YEAR	VOLUME (CY)
1987	378,980
1988	900,905
1989	1001,563
1992	571,466
1997	68,701
1998	350,000 (estimated)

c. Effects of sediment on levee freeboard.

A preliminary HEC-2 run, using the 1997 hydrographic surveys, indicates that only 2.4 feet the original design 5.0 ft of levee-freeboard remains above the computed Standard Project Flood profile. Modeling of the as-built reservoir, using 1974 bathymetry, indicated that there was actually 6 feet of freeboard above the SPF in 1974. The present condition represents a loss of about 3.6 ft of freeboard since 1974, and a loss of 0.5 feet since the last complete survey in 1995. Most of the recent sediment is distributed throughout the pool downstream of the confluence. Since the effect of sediment on the levee-freeboard decreases with distance downstream from the levees, attempts to recover lost freeboard will require a larger dredged volume than would be the case if the dredging could be accom-

plished in the confluence area. Alternatively, original-bed gravels could be dredged in the confluence in lieu of a larger volume downstream.

2. FUTURE DREDGING REQUIREMENTS IN LOWER GRANITE POOL.

Dredging requirements in Lower Granite Pool consist of dredging for navigation near the ports of Clarkston and Lewiston, dredging to maintain freeboard, and some minor maintenance dredging in the marinas at the Corps Resource Office, Chief Looking Glass Park, and Hellsgate Marina, and possible future dredging at the Red Wolf Marina. Future dredging at the marinas probably will not exceed an average total of 3,000 cubic yards per year.

The estimated dredging requirements listed below were based on extrapolations from the 1986 base-year when HEC-6 modeling was used to estimate future dredging requirements. Since 40% of the existing sediment has accumulated since 1986, the extrapolated values should be verified by sediment-transport modeling prior to completion of this study.

The following assumptions were made:

a. That the sediment inflow and distribution projections from the 1986-based study were still valid and that the total dredge volume, required to maintain a given freeboard throughout the project life (1974-2074), would be the same.

b. That dredging for freeboard would not begin before the year 2001. So, instead of having 88 years (1987-2074 inclusive) to remove this volume, there will only be 74 years (2001-2074).

c. That an attempt should be made to recover the design freeboard and catch up to a reasonable, long-term dredging plan within no more than 10 years.

The dredging plans described below consist of a catch-up period, an extension to the 20-year period covered by this study, and a listing of the average dredging requirements for the remainder of the project life. One plan maximizes on-land disposal, while the other plan maximizes in-water disposal.

a. On-land disposal with no levee raise.

The proposed dredging area would start at R.M. 1.66 on the clearwater and R.M. 139.43 on the Snake River. Dredging would progress in a downstream direction cleaning out the channel and cutting a 750- to 2000 ft wide trapezoidal template into the original bed gravels. Every 5 years the dredging operation would move back upstream to the starting point and clean out the excavated channel before extending the template farther downstream. By the year 2074 the template would have reached RM 132.05. HEC-6 sediment transport modeling, based on 1986 geometry, indicated that 116 mcy of sediment would need to be removed over the life of the project. Of this amount 3.3 mcy is expected to be dredged by past and future maintenance operations leaving a total of 112.7 mcy to be dredged after the year 2000.

DATES	YEARS	R.M. LOCATION	MCY/Y ANNUAL-RATE	MCY GRAVEL	MCY TOTAL VOL
2001-2010	10	139.64-136.29	2.69	6.0	26.9
2011-2020	10	139.64-135.15	1.34	2.0	13.4
2021-2074	54	139.64-132.05	1.34	6.0	72.4

b. In-water disposal with 3-ft levee raise.

The dredging sequence, general location, and template would be the same as above. However, the total dredge requirement starting in the year 2001 would be 100.7. This figure represents the 104 mcy dredging requirement in 1986 minus the 3.3 mcy dredging volume in the period 1987-2000. The estimated capacity for inwater-disposal would be 75.2 mcy in the year 2001. This figure represents the 78 mcy capacity in 1986 reduced by the 2.8 mcy of material placed in-water between 1987-2000. This will leave approximately 25.5 mcy of dredge material to be placed on-land. The estimated on-land disposal quantities may be reduced somewhat by consolidation of the inwater fill.

DATES	YEARS	R.M. LOCATION	MCY/Y ANNUAL RATE	MCY GRAVEL	MCY TOTAL VOL
2001-2010	10	139.64-136.29	2.4	6.0	23.9
2011-2020	10	139.64-135.15	1.2	2.0	12.0
2021-2074	54	139.64-132.05	1.2	6.0	64.8

3. FUTURE DREDGING REQUIREMENTS FOR OTHER AREAS.

Estimates of future dredging requirements in Little Goose, Lower Monumental, Ice Harbor, and McNary are not expected to differ greatly from the values listed on Table 11 of the "Dredge Material Management Plan: Preliminary Assessment," dated February 1997. These estimates will be reviewed in greater detail as time permits, taking into consideration recent surveys at Schultz Bar, and McNary Pool. However, there was an attempt to be conservative in estimating the volume of future dredging due to growth of deltas and maintenance of port facilities. Factors which would likely increase dredging requirements in the lower reservoirs are: 1) Development of additional port facilities; 2) Growth of deltas in areas served by a port; 3) Upstream reservoir drawdowns; 4) Increased sediment delivery due to development, changes in forestry, or agricultural practices in the watershed.